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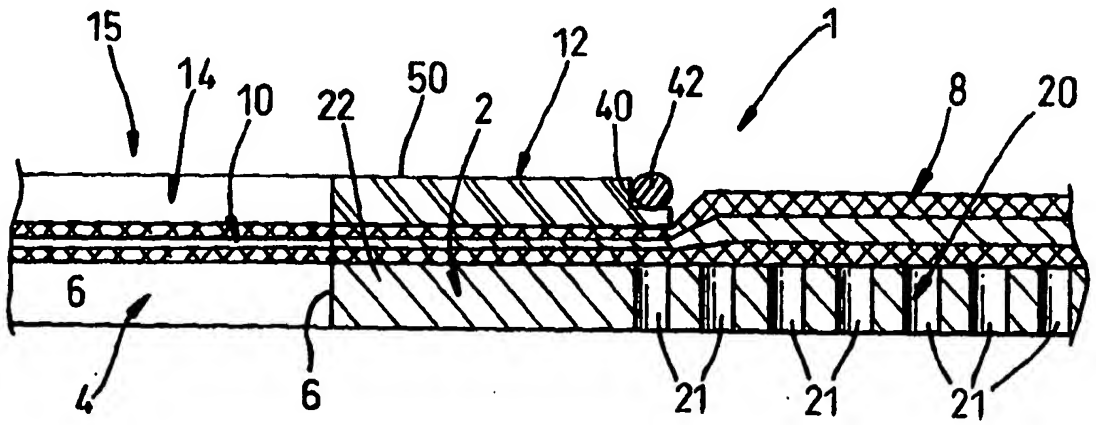


(57) Abstract

Known filter capsules are constructed of two annular discs of filter material which are assembled onto the outward surfaces of two respective support discs. The discs of filter material are secured onto the support disc by a swaged ring collar which clamps the discs of filter material and the support discs together forming a bi-laminate assembly. As a result of the support discs being cut from a sheet which is formed with a plurality of holes, the radially innermost face and radially outermost face of the respective support discs includes some sections of the surfaces which define some of the holes, and the respective support disc faces do not, therefore, have a smooth surface. The present invention provides an annular filter cell assembly (1) comprising a circular support disc (2) formed with a central aperture (4) defined by a smooth radially innermost surface (6), a circular filter element (8) and an annular ring (12), the arrangement being such that the filter element (8) is held between the support disc (2) and the annular ring (12) and the radially innermost surface (6) of the support disc (2) is bonded to the radially innermost surface of the annular ring (12) such that the filter cell assembly (1) defines a common axial through port (15).

# FILTER DISC ASSEMBLY AND FILTER DISC CAPSULES

Description of **WO9852671**

FILTER DISC ASSEMBLY AND FILTER DISC CAPSULES
The present invention relates to a filter cell assembly for a filter disc capsule and stacked filter disc capsules and is concerned particularly, although not exclusively, with stacked filter disc capsules used in polymer processes.

For many polymer processes stacked filter disc capsules are the established method of polymer filtration. The filter disc capsules are particularly suitable where very fine filtration is required and high differential pressures are experienced across the filter element.

The known filter capsules are constructed of two annular discs of filter material which are assembled onto the outward surfaces of two respective support discs. The discs of filter material are secured onto the support disc by a swaged ring collar which clamps the discs of filter material and the support discs together forming a bi-laminate assembly. The respective assemblies are placed either side of an annular support mesh so forming the filter capsule. The filter capsule is formed with a central bore through which filtrate may flow. A plurality of filter capsules are placed upon each other to form a filter stack. The support discs of the filter capsules are manufactured by being stamped from a sheet of stainless steel formed with a plurality of holes extending therethrough.

The holes are formed in the sheet by a pressing or punching process. A result of the support discs being cut from the sheet formed with the holes is that the radially innermost face and radially outermost face of a support disc include some sections of the surfaces which define some of the holes, and the respective support disc faces do not therefore have a smooth surface.

According to a first aspect of the present invention there is provided an annular filter cell assembly comprising a substantially circular support disc formed with a central aperture defined by a substantially smooth radially innermost surface, a substantially circular filter element formed with a central aperture and an annular ring formed with a central aperture, the arrangement being such that, in use, the filter element is held between the support disc and the annular ring and the radially innermost surface of the support disc is bonded to the radially innermost surface of the annular ring such that the respective central apertures define a common axial through port.

Preferably the support disc and the annular ring are bonded together by a welding process. It is preferable that the assembly is of metal material.

The preferred metal material is stainless steel.

Preferably the welded portion of the assembly provides a fluid tight seal, the arrangement being such that, in use, the welded portion prevents radial fluid flow through the region of the filter element secured between the annular ring and the support disc.

Preferably the arrangement is such that the contiguous radially innermost portions of the support disc, the filter element and the annular ring are welded together such that the filter element is secured between the annular ring and the support disc.

The radially innermost faces of the annular ring and the support disc are preferably each formed with a substantially smooth circular surface prior to welding.

The axially outermost face of the annular ring is preferably substantially flat and the axially outermost surface of the support disc is preferably substantially flat, the arrangement being such that, in use, the said substantially flat surfaces provide a fluid tight sealing means when abutted against another flat surface.

The support disc is preferably formed by an etching process.

Preferably the etching process forms a plurality of fluid ducts through the support disc.

The etching process is most preferably a photo-etching process.

Preferably the substantially circular support disc comprises a radially intermediate region formed with a

plurality of fluid ducts extending therethrough; the arrangement of the fluid ducts being such that the support disc comprises an inner ring portion comprising no fluid ducts, the inner ring portion extending radially outwardly from the radially innermost edges of the support disc and an outer ring portion comprising no fluid ducts, the outer ring portion extending radially inwardly from the radially outermost edges of the support disc, and the arrangement being such that the filter element substantially covers one face of the support disc, and the annular ring is disposed around the axial through port on the outward face of the filter element and covering only a part of the filter element; the contiguous radially innermost portions of the support disc and the annular ring are secured together such that the filter element is held between the annular ring and the support disc.

According to a second aspect of the present invention there is provided a filter disc capsule comprising two filter cell assemblies, each in accordance with the first aspect of the present invention, and a substantially annular inner filter support element encased between the two filter cell assemblies; the radially outermost circumferences of the filter cell assemblies being secured together.

Preferably the radially outermost circumferences of the filter cell assemblies are secured together by a welding process.

The welding process is preferably a tungsten inert gas (TIG) welding process.

Alternatively, the welding process is a plasma welding process.

According to a third aspect of the present invention there is provided a stack of filter disc capsules, each in accordance with the second aspect of the present invention, the arrangement being such that the stack of filter disc capsules form a common central fluid output channel through which filtered fluid is carried from the stack.

According to a fourth aspect of the present invention there is provided a stack of filter cell assemblies each in accordance with the first aspect of the present invention, and a substantially annular inner filter element being encased between the two filter cell assemblies, the arrangement being such that respective pairs of adjacent filter cell assemblies are bonded to a common annular ring.

The invention also includes a method of making a stack of filter cell assemblies according to the fourth aspect of the invention comprising first placing a first filter assembly under a compressive pressure, then bonding the radially innermost surface of the support disc to the radially innermost surface of the common annular ring; then releasing the compressive pressure and placing the components of a second filter cell assembly on the common annular ring and placing the two assemblies under a compressive pressure; then bonding the second filter cell assembly support ring to the common annular ring and releasing the compressive pressure.

Support means for a stack of annular filter capsules comprising a plurality of struts, each attached to the radially outermost surfaces of the filter capsules and each strut being substantially parallel to the axis of the stack.

It will be appreciated that the above method can be repeated until the required number of filter cell assemblies have been bonded together to form a filter stack.

An embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:
Figure la shows a cross-section of the radially innermost region of a filter cell assembly prior to the bonding of the support disc to the annular ring;
Figureib shows the filter cell assembly shown in Figure la after the bonding of the support disc and the annular ring,
Figure 2 shows a cross-section of a filter disc capsule,
Figure 3 shows an enlarged cross-section of the radially outermost region of the filter disc capsule,
Figure 4 shows a further enlarged cross-section view of the radially innermost region of filter disc capsule,
Figure 5 shows a plan view of the filter disc capsule,
Figure 6 shows a vertical cross-section view of a stack of filter disc capsules, and
Figure 7 shows a further embodiment of a stack of filter disc capsules.

Referring to Figure1a, an annular filter cell assembly 1 comprises a substantially circular support disc 2 formed with a central aperture 4 defined by a smooth radially innermost surface 6, a substantially circular filter media disc 8 formed with a central aperture 10 and an annular ring 12 formed with a central aperture 14, the radially innermost part of the filter media disc 8 is compressed between the support disc 2 and the annular ring 12 and the arrangement is such that respective apertures define a common axial through port 15.

Figure1b shows the filter cell assembly 1 after the radially innermost surface 6 of the support disc 2 has been welded to the radially innermost surface of the filter media disc 8 and the radially innermost surface of the annular ring 12.

Referring to the Figures 2 to 5, a stainless steel filter disc capsule 17 comprises two annular filter cell assemblies 1, 3, an annular castillated spacer ring 7 and an inner support mesh 18.

The filter cell assembly 1 comprises a circular support disc 2, a circular filter media disc 8 and an annular ring 12 (also shown in Figure 6).

The filter cell assembly 3 comprises a circular support disc 5, a circular filter media disc 9 and an annular ring 13 (also shown in Figure 6).

The inner support mesh 18 is made of a stainless steel woven mesh. It will be appreciated that the filter media can be made of any filter structure, according to the process requirements, including sintered bronze and stainless steel powder. The circular filter media discs 8, 9 are made of stainless steel woven mesh but can be made from any appropriate filter structure according to the process requirements.

The filter disc capsule 17 defines a main fluid exit port 19 extending through the assembly about an axis XX. The circular support discs 2, 5 are formed with an intermediate region 20, 20' in which a plurality of circular fluid ducts 21 extend through the respective support discs 2, 5.

The circular fluid ducts 21 are disposed from the innermost and outermost edges of the said discs 2, 5; the arrangement of the holes being such that the respective discs 2, 5 comprise inner solid ring portions 22, 24 and outer solid ring portions 26, 28. The fluid ducts 21 are formed in the support discs by a photo-etching process. As shown in Figure 3, the outer solid ring portions 26, 28 converge such that the respective inner faces thereof abut each other at their radially outermost regions.

The outward faces of the support discs 2, 5 support the respective filter media discs 8, 9, and the radially innermost regions of the respective filter media discs 8, 9 are secured between the annular rings 12, 13 and the support discs 2, 5.

The radially innermost region of the support disc 2; the filter media disc 8 and the annular ring 12 are welded around their inner circumference 30 such that the filter media disc 8 is held between the said annular ring 12 and the support disc 2.

The radially innermost region of the support disc 5; the filter media disc 9 and the annular ring 13 are welded around the inner circumference 32 such that the filter media disc 9 is held between the said annular ring 13 and the support disc 5.

The respective radially innermost welded portions are separated by the castillated spacer ring 7. The spacer ring 7 is held in position by a series of tack welds securing the ring 7 to the respective support discs 2, 5.

The spacer ring is formed with alternate upper and lower fluid channels 36 extending radially outwardly through the ring 7 from the fluid exit port 19. The fluid channels provide fluid communication between the inner support mesh 18 and the fluid exit port 19 and are manufactured by a chemical etching process.

The welded portions provide a fluid tight seal, the arrangement being such that in use the welded portions prevent radial fluid flow through the region of the filter element secured between the annular ring and the support disc. The welded portions are formed using an automated tungsten inert gas (TIG) welding process.

The radially outermost regions of the support discs 2, 5 and the filter media discs 8, 9 are welded together around the outermost circumference.

The weld provides a fluid tight seal and bonds together the support discs 2, 5 and the filter media discs 8, 9.

The respective annular rings 12, 13 are formed with annular stepped recesses 40, 41 disposed at the radially outermost outwardly facing corners with respect to the axis XX. The respective recesses 40, 41 are adapted to receive circular sealing rings 42, 43.

Additional support means for the filter capsule is provided by an annular support ring, 46 comprising a plurality of spokes 48 extending radially outwards from the support ring 46, commonly know in the filter industry as a 'spider'. The radially outermost ends of the spokes 48 are formed with an inwardly directed bend. The end of the bend is welded to the radially outermost circumference of the assembly 17. The spider is manufactured by an etching process. This could also be manufactured by a constructed method and welded.

The filter cell assembly 17 comprises an upper outwardly facing fluid sealing surface 50 and a lower outwardly facing fluid sealing surface 52.

The assembly 17 also comprises a secondary fluid sealing means formed by the abutting surfaces of the respective inwardly facing surfaces of the two support discs 2, 5 and the outwardly castillated spacer ring 7.

Referring to Figure 6, a plurality of filter disc capsules 17 are placed together on top of each other so forming a filter stack 60. The filter stack 60 defines a common central fluid output conduit 62, through which filtered fluid is carried from the stack 60. In use the filter stack is placed within a filter vessel (not shown) and the stack is placed under an axial compressive pressure. The radially innermost welded portions 30, 32 of each of the filter disc capsules provide an improved means by which to transfer the compressive stress through the stack of filter cell assemblies.

With reference to Figure 7, an embodiment of the present invention comprises a stack 70 of filter capsules 71 comprising filter assemblies 1, 3 and wherein adjacent filter assemblies 1, 3 are bonded to a common annular ring 72. The same reference numerals have been used in Figure 7 for the common features shown in Figures Ia to 6 and hereinbefore described. No further description of the common features will be given.

hereinbefore described. No further description of the common features will be given.

The capsule 70 forms a substantially stronger filter stack structure. The radially innermost surface of the common annular ring 72 is formed with a C-shaped channel section 74 which extends around an innermost circumference of the annular ring 72.

The arrangement of the C-shaped channel section 74 provides two inner annular rims 76, 78. The inner annular rims 76, 78 are welded to the respective radially innermost surfaces of the support discs 2, 5 and the filter media discs 8, 9.

In the method of manufacturing the filter stack 70, firstly the parts of a filter capsule, including the common annular ring, are placed under a compressive pressure, preferably about 5 tons, and the radially innermost surfaces of the support discs and the filter discs are welded together so forming a fluid tight seal and retaining the filter discs therebetween.

The pressure is then released. A second set of parts of a filter capsule is placed on the uppermost surface of the common annular ring and pressure is re-applied. The radially innermost surfaces of the second support discs and the second filter discs of the second filter capsule are welded together. The pressure is then released and a third set of parts of a filter capsule is placed on the uppermost surface of the annular ring and the process is repeated as described above. At each end of the stack there is used an annular ring 80 formed with a single rim 82.

It will be appreciated that the welded filter stack 70 comprises a plurality of filter capsules 71 that are permanently welded together.

The filter stack 60 shown in Figure 6 comprises a plurality of filter capsules 17. The respective sealing surfaces 50, 52 of each capsule 17 provide a fluid tight seal. In addition each annular ring can also comprise sealing rings 42, 43.

The use of the common annular rings 72 means that there is no sealing surfaces between the adjacent filter capsules 71 and no need for sealing rings.

There is no sealing means required between adjacent filter capsules due to the capsules being welded to

the common annular ring. This embodiment of the present invention provides an advantage over the stack of filter capsules shown in Figure 6.

Welded to the radially outermost surface of each filter capsule 71 are a plurality of support bars 90. The support bars 90 are substantially parallel to the axis XX and extend the length of the filter stack 70. In use the filter capsules 70 experience high differential pressures across the filter surface. This differential pressure can cause the filter capsules 70 to bend and buckle. The support bars 71 prevent the ends of the filter capsules 70 from moving.

Support bars 90 can be used on any similar filter stack, including the filter stack 60 shown in Figure 6.

It will be appreciated that the stack assemblies described above provide sealing means when the respective assemblies are in use. The axial pressure (usually about 5 tons) applied to the stack assemblies provides sufficient pressure to the respective, abutting sealing surfaces, of the stack assemblies, to prevent leakage between the abutting sealing surfaces.

The above described stack assemblies also provide an improved strength and sealing throughout the body of components which helps to withstand the axial pressure applied to the stack.

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# FILTER DISC ASSEMBLY AND FILTER DISC CAPSULES

Claims of **WO9852671**

CLAIMS

1. An annular filter cell assembly (1) comprising a substantially circular support disc (2) formed with a central aperture (4); a substantially circular filter element (8) formed with a central aperture (10) and an annular ring (12) formed with a central aperture (14), characterised in that the central aperture (4) of the substantially circular support disc (2) is defined by a substantially smooth radially innermost surface (6), the arrangement being such that, in use, the filter element(8) is held between the support disc (2) and the annular ring (12) and the radially innermost surface (6) of the support disc is bonded to the radially innermost surface of the annular ring (12) such that the respective central apertures define a common axial through port (15).

2. An annular filter assembly (1) as claimed by claim 1 wherein the support disc (2) and the annular ring (12) are bonded together by a welding process.

3. An annular filter assembly (1) as claimed by claim 1 or claim 2 wherein the assembly is of metal material.

4. An annular filter assembly (1) as claimed by claim 3 wherein the metal material is stainless steel.

5. An annular filter assembly (1) as claimed by any one of claims 2, 3 or 4 wherein the welded portion (30) of the assembly provides a fluid tight seal, the arrangement being such that, in use, the welded portion (30) prevents radial fluid flow through the region of the filter element(8) secured between the annular ring (12) and the support disc (2).

6. An annular filter assembly (1) as claimed by any one of the preceding claims wherein the arrangement is such that the contiguous radially innermost portions of the support disc (2), the filter element (8) and the annular ring (12) are welded together such that the filter element (8) is secured between the annular ring (12) and the support disc (2).

7. An annular filter assembly (1) as claimed by any one of claims 2 to 6 wherein the radially innermost faces of the annular ring (12) and the support disc (2) are each formed with a substantially smooth circular surface prior to welding.

8. An annular filter assembly (1) as claimed by any one of the preceding claims wherein the axially outermost face (50) of the annular ring (12) is substantially flat and the axially outermost surface of the support disc (2) is substantially flat, the arrangement being such that, in use, the said substantially flat surfaces provide a fluid tight sealing means when abutted against another flat surface.

9. An annular filter assembly (1) as claimed by any one of the preceding claims wherein the support disc (2) is formed by an etching process.

10. An annular filter assembly (1) as claimed by claim 9 wherein the etching process forms a plurality of fluid ducts (21) through the support disc (2).

11. An annular filter assembly (1) as claimed by claim 10 wherein the etching process is a photo-etching process.

12. An annular filter assembly (1) as claimed by any one of the preceding claims wherein the substantially circular support disc (2) comprises a radially intermediate region (20) formed with a plurality of fluid ducts (21) extending therethrough; the arrangement of the fluid ducts being such that the support disc (2) comprises an inner ring portion (22) comprising no fluid ducts, the inner ring portion (22) extending radially outwardly from the radially innermost edges of the support disc (2) and an outer ring portion (26) comprising no fluid ducts, the outer ring portion (26) extending radially inwardly from the radially outermost edges of the support disc (2), and the arrangement being such that the filter element (8) substantially covers one face of the support disc (2), and the annular ring (12) is disposed around the axial through port (15) on the outward face of the filter element (8) and covering only a part of the filter element (8); the contiguous radially innermost portions of the support disc (2) and the annular ring (12) are secured together such that the filter element (8) is compressed between the annular ring (12) and the support disc

(2).

13. A filter disc capsule (17) comprising two filter cell assemblies (1, 3), as claimed by any one of the preceding claims 1 to 12, and a substantially annular inner filter support element (18) encased between the two filter cell assemblies (1, 3); the radially outermost circumferences of the filter cell assemblies (1,3) being secured together.

14. A filter disc capsule (17) as claimed by claim 13 wherein the radially outermost circumferences of the filter cell assemblies (1,3) are secured together by a welding process.

15. A filter disc capsule (17) as claimed by claim 14 wherein the welding process is preferably a tungsten inert gas (TIG) welding process.

16. A filter disc capsule (17) as claimed by claim 14 wherein the welding process is a plasma welding process.

17. A stack (60) of filter disc capsules (17), as claimed by any one of claims 13 to 16 wherein, the arrangement is such that the stack of filter disc capsules (60) form a common central fluid output channel (62) through which, in use, filtered fluid is carried from the stack.

18. A stack (70) of filter cell assemblies (1, 3) as claimed by any one of the claims 1 to 12 wherein, a substantially annular inner filter element (18) is encased between pairs of filter cell assemblies (1, 3), the arrangement being such that respective pairs of adjacent filter cell assemblies (1, 3) are bonded to a common annular ring (72).

19. A stack (70) of filter cell assemblies (1, 3) as claimed by claim 18 wherein pairs of filter cell assemblies (1, 3) form a filter capsule (71).

20. A method of making a stack (70) of filter cell assemblies (1, 3) as claimed by claim 18 comprises first placing a first filter assembly under a compressive pressure, then bonding the radially innermost surface of the support disc (2) to the radially innermost surface of the common annular ring (72); then releasing the compressive pressure and placing the components of a second filter cell assembly on the common annular ring (72) and placing the two assemblies under a compressive pressure; then bonding the second filter cell assembly support ring to the common annular ring (72) and releasing the compressive pressure.

21. Support means for a stack (70) of annular filter capsules (71) comprising a plurality of struts (90), each attached to the radially outermost surfaces of the filter capsules (71) and each strut (90) being substantially parallel to the axis (X) of the stack.

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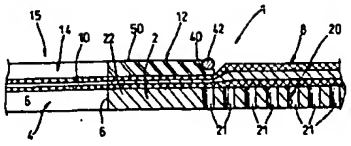

Fig. 1a

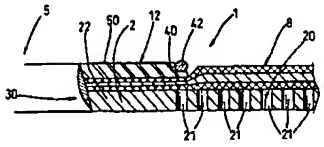

Fig. 1b





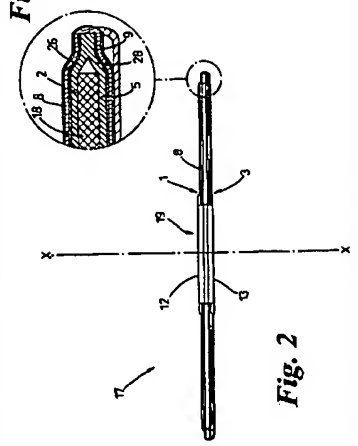

Fig. 3

Fig. 2





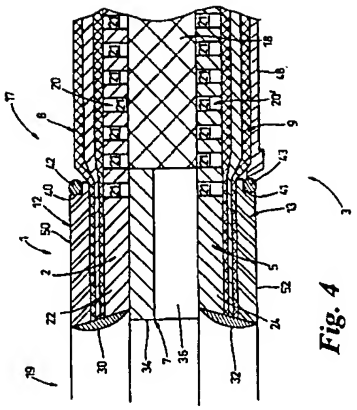

Fig. 4





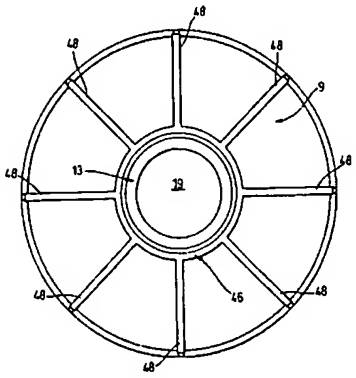

Fig. 5





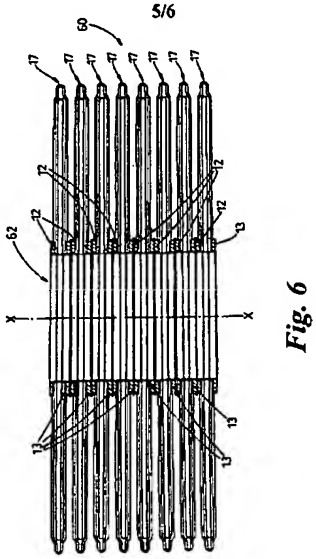

Fig. 6





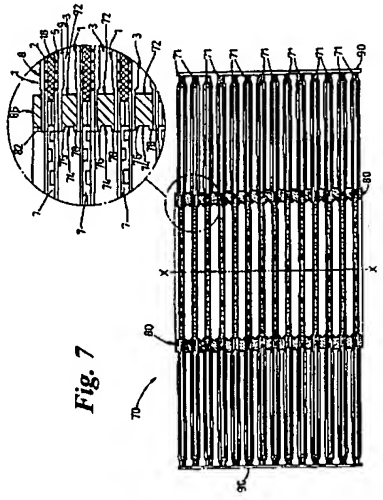

Fig. 7